
10 Underdrains

Types of Underdrains

Pre-Construction

Trench Excavation

Construction Requirements

Pipe Installation

Geotextiles

Backfill

Underdrain Outlets

Outlet Protectors

Video Inspection

Materials and Basis for Use

Measurement

Basis of Payment

CHAPTER TEN: UNDERDRAINS

The reduction of the moisture content of the subgrade is very important for a stable and long-lasting pavement. One procedure used for reducing subgrade moisture is underdrains. In general terms, an underdrain requires the following:

- 1) A trench excavated along the edge of the pavement deep enough to drain the subgrade and with adequate slope to drain properly.
 - 2) A perforated pipe or pipe with open joints placed in the trench bottom to provide for entry and movement of water.
 - 3) Trench backfill with granular filter material to allow ready entry of water from any soil layer above the bottom of the pipe.
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TYPES OF UNDERDRAINS

The types of pipe allowed for underdrain installations by Section **718** are as follows:

- 1) Corrugated Polyethylene Drainage Tubing
- 2) Corrugated Polyethylene Pipe, Type SP
- 3) Non-Reinforced Concrete Pipe
- 4) Perforated Polyvinyl Chloride Semicircle Pipe
- 5) Profile Wall Polyvinyl Chloride Pipe

The item usually specified in the contract is “Type 4 Pipe for underdrains” and per Standard Sheet **MP** any of the above pipe may be used. Outlet pipes for underdrains are required to be non-perforated sections of one of the above metal pipes.

The item most often used is the plastic corrugated drainage pipe (Figure 10-1). This pipe is delivered in long rolls to reduce the number of splices, and is very durable, easily cut, and easily spliced.



Figure 10-1. Plastic Corrugated Drainage Pipe

PRE-CONSTRUCTION

Due to the stabilizing effect of underdrains on the highway subgrade, the underdrains are required to be installed properly. A major step to proper installation of underdrains is planning.

Prior to installation, the PE/PS is required to review the contract to determine the need for underdrains. Granular materials, less than 10% passing the No. 200 sieve, in well-drained fills do not require underdrains. The underdrains are eliminated only if the same granular material is brought up to the subgrade elevation. A new borrow source may consist of materials that would require underdrains.

Prior to installation, the technician is required to check the contract for positive underdrain drainage as follows:

- 1) Check the necessity for special grades and depths. In poorly drained areas, go deeper, if possible, to ensure positive drainage.
- 2) Check to see that minimum slope requirements are met. Usually, the minimum slope is listed in the Plan General Notes and is 0.2 % or 0.2 ft/100 ft. Special grades are established if the profile grade is less.
- 3) Check outlet pipes to verify that they will drain, rather than raise a length of underdrain to provide for outlet drainage. Relocating the outlet for better drainage may be necessary.
- 4) Check for conflicts with cross structures. Make sure there is an outlet before a structure or that the underdrain is high enough to clear the structures. If the outlet is into a cross

structure, make sure the underdrain is high enough to provide positive drainage. Do not allow the underdrain to saturate the subgrade anytime there is rain.

Using form I.C. 401A or a Field Book, the technician is required to sketch the underdrains showing all related items and plan quantities. This is done for the following reasons:

- 1) To familiarize the technician with the work
- 2) To help detect possible conflicts
- 3) To show where special grades and depths are required
- 4) To provide a sheet for the Final Construction Record showing quantities actually placed. If plan quantities change, the quantity is crossed out and the placed quantities written in.

The I.C. 401A or Field Book should be set up as shown on Figures 10-2 and 10-3. Figure 10-2 indicates how the underdrains look when set up prior to the work. Figure 10-3 shows how the underdrains look after the completion of the work.

TRENCH EXCAVATION

Underdrains are required to be placed as soon as possible after the subgrade is substantially complete to promote positive drainage and expedite construction. Construction of the trench is required to be as follows:

FORM I.C. - 401A
 REV. 5-1-63

INDIANA DEPARTMENT OF HIGHWAYS
CONSTRUCTION RECORD

Page No. _____

M-N Project No. 326(1) Section _____
Contract No. R-14212

ITEM 6" Pipe - Gr. "K" For Underdrains
ITEM No. 31

STATIONS	Depth CHD- WIDEN FEET	Av. Depth SUM OF END WIDTHS FEET	Length LINEAL DISTANCE Group K	Volume/Fc. AREA FOOT *	TOTAL VOLUME
13+50	2.6				
17+00	2.6				
18+00	2.0				
18+50	2.2				
19+00	2.4				
19+50	2.5				
20+00	2.6				
25+00	2.6				
10+00	2.0				
13+00	2.0				
13+50	2.2				
16+50	3.4				
17+00	3.4				
17+50	3.3				
18+00	3.2				
19+00	3.2				
19+50	3.1				
20+50	3.1				
21+50	2.5				
25+00	2.5				
13' Lt.	2.6				
13' Rt.	2.2				

TRANSVERSE AT 13+50

Left

Right

NOTES, SKETCHES AND REMARKS

Set up, prior to underdrain placement, of an I.C. 401A for a 2 lane highway. One side of a four lane divided highway will be similar. See next page for changes and additions made to this form during underdrain placement.

* From Table 107, Final Construction Record Guide.

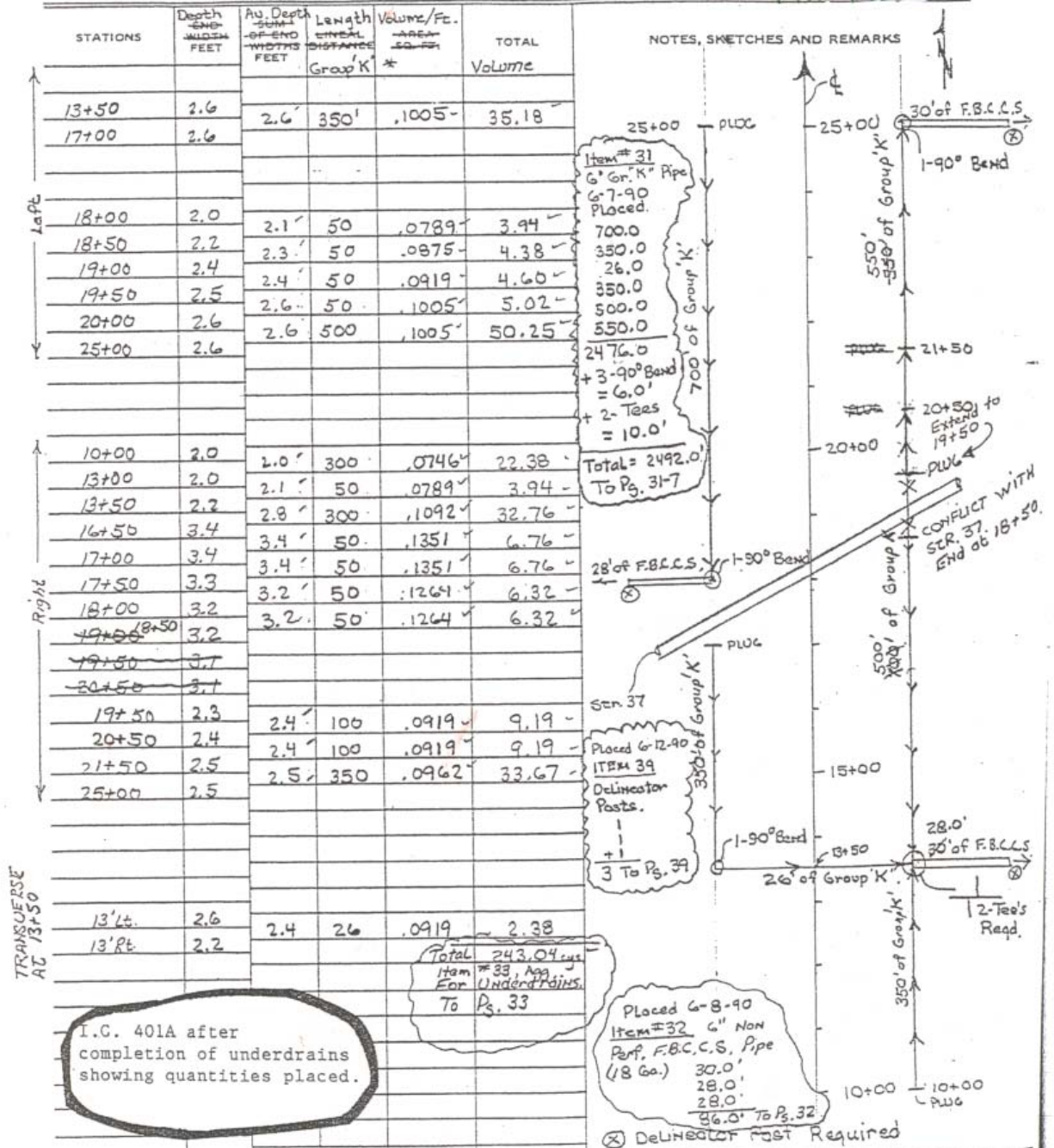
Sheet UD-1

COMPILED BY _____
CHECKED _____

Figure 10-2. Underdrain Locations Prior to Work

INDIANA DEPARTMENT OF HIGHWAYS
CONSTRUCTION RECORD

M-N Project No. 326(1) Section _____ Contract No. R-14272
ITEM 6" Pipe-Gr. "K" For Underdrains ITEM No. 31



Sheet UD-2

Figure 10-3. Underdrain Locations after Completion of Work



Figure 10-4. Underdrain Trencher

Trench excavation is required to begin at the outlet end and proceed towards the upper end. The trench excavation is made to the required line and grade. The trench depth is required to be checked to ensure that the depth paid for is obtained. The trench bottom is shaped as shown on Standard Sheets **718-UNDR-01** thru **718-UNDR-07**. Recesses are cut in the trench bottom to receive any projecting pipe hubs or bells. If the trench is excavated too deep, the trench is backfilled to the required elevation with approved soil. Cave-ins are re-excavated, if necessary.



Figure 10-5. Underdrain Trench

CONSTRUCTION REQUIREMENTS

PIPE INSTALLATION

The pipe is laid into the trench. Splices and other connections are required to be correctly made. Perforated pipe is placed with holes down, to keep out silt, gravel, and other solids. Plastic corrugated drainage pipe is unrolled into the trench. Minor cave-ins that occur after pipe placement do not have to be cleaned. The pipe sections are joined securely with the appropriate couplings, fittings, or bands. If plain end concrete pipe is being placed, no joint width may exceed 1/4 in.

GEOTEXTILES

Storage and handling of geotextiles is required to be in accordance with the manufacturer's recommendations. Each geotextile roll is required to be labeled or tagged. Damaged or defective geotextile are replaced as directed. The geotextile is placed loosely, but with no wrinkles or folds. The ends of subsequent rolls of geotextile are overlapped a minimum of 1 ft. The upstream geotextile overlaps the downstream geotextile. Placement of the aggregate is done following the placement of the geotextile.

BACKFILL

The trench is backfilled with No. 8 or No. 9 stone, slag, or gravel. Coarse aggregate No. 8 or 9 is used for 6 in. underdrain installations and coarse aggregate No. 9 is used for 4 in. underdrain installations. The backfilling operation is done with a device designed to fill the trench without promoting cave-ins. Prior to placing open graded HMA above the underdrain aggregate, the underdrain aggregate is required to be clean and exposed to facilitate drainage.

After the outlet pipe installation, the trench is backfilled as shown on the plans. B Borrow for structure backfill may not extend into the limits of the underdrain trench. The trench outside of the limits of B borrow for structure backfill is filled with materials suitable for growing vegetation. Aggregate and stabilized materials removed from an existing shoulder may not be used as backfill and are disposed of in accordance with Section **206.07**.

UNDERDRAIN OUTLETS

Pipe screens are placed in the end of the outlet pipe (Figure 10-7) as shown on Standard Sheet **718-UNDR-06**. At the time of installation, a rodent screen is placed on the outlet pipe or the ends of the underdrain

pipe when located in inlets or catch basins. Rodent screens are required to be woven stainless steel wire mesh or galvanized hardware cloth.

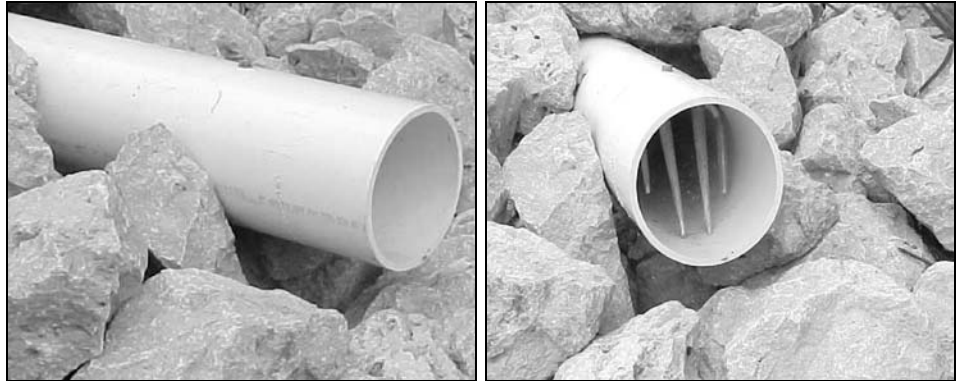


Figure 10-7. Underdrain Outlet

OUTLET PROTECTORS

Underdrain outlet protectors (Figure 10-8) are required to be constructed as shown on the plans. Types 1, 2, and 3 may be used.



Figure 10-8. Underdrain Outlet Protector

VIDEO INSPECTION

Underdrains and outlets are required to be inspected using high resolution, high sensitivity, waterproof, color video camera/recording equipment. The camera/recording equipment is specifically designed for continuous viewing and recording of detailed images of the interior wall of pipes and transitions of the specified sizes. The equipment has the capability of viewing a minimum of 450 ft into the pipes and is designed to include sufficient lighting to view the entire periphery of the pipe. The equipment has appropriate attachments to maintain a position in the center of the pipe and an electronic counter to continuously record the location of the equipment in the pipe. The recording equipment is required to have a minimum four head industrial grade VHS recorder or digital archiving and reviewing for printing observations during inspection.

The PE/PS determines the runs of the underdrain installations to be inspected. Video inspection is conducted after guardrail, lighting, sign installation, and final seeding or sodding operations are completed.

Damage discovered by the video inspection is required to be repaired. Damage includes but is not limited to crushed or partially crushed pipes that impede the progress of the camera, blockages, vertical pipe sags filled with water depth of $d/2$ or greater, 90 degree connections, connector separations, cracks, or splits in the pipes. All repaired sections are video reinspected prior to acceptance. A copy of the video inspection is submitted to the PE/PS.

MATERIALS AND BASIS FOR USE

All materials in an underdrain installation are required to meet the requirements of Section **718.02**. Specific Specifications and Material Record Basis for Use requirements for the most commonly used items are as follows:

Plastic Corrugated Pipe

- 1) Section **906.17**
- 2) Basis for Use is a Type A Certification and a visual inspection for required dimensions and workmanship.

Aggregate

- 1) Section **904**
- 2) The Basis for Use is the “D” number from the CAP source.

MEASUREMENT

Underdrains and outlet pipes are measured by the linear feet installed as follows:

- 1) Tee and wye fittings are measured along the centerline of the barrel and an additional 5 ft of the same diameter pipe is paid for making the connection. If one of the pipes is a smaller diameter, then the 5 additional ft is paid at the price of the smaller diameter pipe.
- 2) Elbow connections are measured along the center-line of the elbow and an additional 2 ft of the same diameter pipe is paid for the connection.
- 3) Increaser and reducer connections are measured by the length of the connection and are paid at the price of the larger diameter pipe.
- 4) Sub-tee connections are measured and paid the same as a tee connection. Payment includes the required connecting bands, cement mortar beads, or concrete collars.

Aggregate is measured by cubic yards complete in place to excavated lines. The trench width may not extend past neat lines shown on the plans, and the trench is required to be as specified.

Underdrains and outlet pipes are measured in accordance with Section **715.11**. Outlet protectors are measured by the number and type of units installed.

B borrow for structure backfill is measured in accordance with Section **211.09**.

HMA for underdrains is measured by the ton.

Geotextiles are measured by the square yard based on the neat limits shown on the plans.

Video inspections for underdrains are measured by the linear foot as determined by the electronic equipment.

Rodent screens, elbows, increaser or decreaser connections, and other incidentals are not measured for payment. Concrete, reinforcing steel, or sod for underdrain outlet protectors are also not measured for payment.

Documentation for measurement and payment is required to be on the I.C. 401A or in the Field Book. The plan quantities are revised to show the actual quantity placed.

BASIS OF PAYMENT

The accepted quantities of underdrains and underdrain outlet pipe are paid for in accordance with Section **715.13**.

Aggregate for underdrains is paid for at the contract unit price per cubic yard.

Geotextile for underdrains is paid for at the contract unit per square yard. Geotextile which has been rejected due to contamination or other reasons is required to be replaced with no additional payment.

Outlet protectors are paid for at the contract unit price per each of the type of unit installed, complete in place.

The accepted quantities of HMA for underdrains are paid for at the contract unit price per ton.

B borrow for structure backfill is paid for in accordance with Section **211.10**.

The final accepted quantity video inspection for underdrain is paid for at the contract unit price per linear foot.

The costs of excavation, forming, reinforcing steel, concrete, curing materials, and sod shall be included in the cost of outlet protector.

The cost of providing the video inspection equipment, technician, videotapes, or computer disks is included in the cost of the underdrain video inspection. The cost of repair of underdrain pipes, aggregates, backfill, outlet protectors, geotextile fabric, etc. is included in the cost of the other pay items. The cost of providing video reinspection of the repairs is included in the cost of the pay items.

The cost of disposal of unsuitable excavated materials, installation of pipe end caps, rodent screens, elbows, increaser or decreaser connections, and other incidentals is included in the cost of other pay items.